

CLAIMS

We claim:

- 1 1. A method of performing reconstruction comprising the
2 steps of:
 - 3 a) saving DS and DD coefficients effected by a boundary;
 - 4 b) reconstructing SD coefficients to be smooth across the boundary;
 - 5 c) applying a vertical inverse transform individually on each tile;
 - 6 d) reconstructing D coefficients to be smooth across the boundary;
 - 7 and
 - 8 e) applying a horizontal inverse transform individually on each
 - 9 tile.
- 1 2. The method defined in Claim 1 further comprising the step
2 of repeating steps a) - e) for each level.
- 1 3. The method defined in Claim 2 wherein said each level
2 comprises an importance level.
- 1 4. The method defined in Claim 1 further comprising the step
2 of making the SD and D coefficients consistent with actual quantized
3 coefficients.
- 1 5. An apparatus for performing reconstruction comprising:

2 means for saving DS and DD coefficients effected by a boundary;
3 means for reconstructing SD coefficients to be smooth across the
4 boundary;
5 means for applying a vertical inverse transform individually on
6 each tile;
7 means for reconstructing D coefficients to be smooth across the
8 boundary; and
9 means for applying a horizontal inverse transform individually
10 on each tile.

1 6. The apparatus defined in Claim 5 wherein the means for
2 saving, means for reconstructing SD coefficients, the means for applying
3 a vertical inverse transform, the means for reconstructing D coefficients,
4 and the means for applying a horizontal inverse transform operate on
5 each level individually.

1 7. The apparatus defined in Claim 6 wherein said each level
2 comprises an importance level.

1 8. The apparatus defined in Claim 5 further comprising means
2 for making the SD and D coefficients consistent with actual quantized
3 coefficients.

1 9. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor,
4 for each level, to:

5 save DS and DD coefficients effected by a boundary,
6 reconstruct SD coefficients to be smooth across the boundary,
7 apply a vertical inverse transform individually on each tile,
8 reconstruct D coefficients to be smooth across the boundary, and
9 apply a horizontal inverse transform individually on each tile.

1 10. A method of performing an inverse transform comprising
2 the steps of:

3 a) performing an inverse vertical transform on SS and SD
4 coefficients only;
5 b) performing the inverse vertical transform on DS and DD
6 coefficients on two current lines of coefficients using DS coefficients from
7 two previous lines;
8 c) performing an inverse horizontal transform for two vertically
9 adjacent S and D coefficient pairs in said two current lines of coefficients;
10 and
11 d) repeating b) and c) for each pair of lines after the two current
12 lines.

1 11. The method defined in Claim 10 wherein quantization of
2 each SD coefficient controls reconstruction limits of two samples.

1 12. The method defined in Claim 10 wherein quantization of
2 DS and DD coefficients controls reconstruction limits of four samples.

1 13. The method defined in Claim 10 wherein the SS and SD
2 coefficients consumed by performing an inverse vertical transform on SS
3 and SD coefficients only are not saved.

1 14. The method defined in Claim 10 wherein the S components
2 are treated as image data in the spatial domain.

1 15. An apparatus for performing an inverse transform
2 comprising:
3 means for performing an inverse vertical transform on SS and SD
4 coefficients only;
5 means for performing the inverse vertical transform on DS and
6 DD coefficients on two current lines of coefficients using DS coefficients
7 from two previous lines;
8 means for performing an inverse horizontal transform for two
9 vertically adjacent S and D coefficient pairs in said two current lines of
10 coefficients; and

11 wherein the means for performing an inverse vertical transform
12 on SS and SD coefficients, the means for performing the inverse vertical
13 transform on DS and DD coefficients, and the means for performing an
14 inverse horizontal transform perform their operations repeatedly for
15 each pair of lines after the two current lines.

1 16. The apparatus defined in Claim 15 wherein quantization of
2 each SD coefficient controls reconstruction limits of two samples.

1 17. The apparatus defined in Claim 15 wherein quantization of
2 DS and DD coefficients controls reconstruction limits of four samples.

1 18. The apparatus defined in Claim 15 wherein the SS and SD
2 coefficients consumed by performing an inverse vertical transform on SS
3 and SD coefficients only are not saved.

1 19. The apparatus defined in Claim 15 wherein the S
2 components are treated as image data in the spatial domain.

1 20. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor
4 to:

- 5 a) perform an inverse vertical transform on SS and SD coefficients
- 6 only,
- 7 b) perform the inverse vertical transform on DS and DD
- 8 coefficients on two current lines of coefficients using DS coefficients from
- 9 two previous lines,
- 10 c) perform an inverse horizontal transform for two vertically
- 11 adjacent S and D coefficient pairs in said two current lines of coefficients,
- 12 and
- 13 d) repeat b) and c) for each pair of lines after the two current lines.

- 1 21. A method of creating a preferred reconstruction comprising
- 2 the steps of:
- 3 a) for each SD coefficient, computing a preferred reconstruction
- 4 and clipping the preferred reconstruction to be consistent with
- 5 quantization;
- 6 b) performing an inverse vertical transform on SS and SD
- 7 coefficients only;
- 8 c) for each DS and DD coefficient, computing a preferred
- 9 reconstruction and clipping the preferred reconstruction to be consistent
- 10 with quantization;
- 11 d) performing the inverse vertical transform on DS and DD
- 12 coefficients on two current lines of coefficients using DS coefficients from
- 13 two previous lines;

14 e) performing an inverse horizontal transform for two vertically
15 adjacent S and D coefficient pairs in said two current lines of coefficients;
16 and
17 f) repeating d) and e) for each pair of lines after the two current
18 lines.

1 22. The method defined in 21 further comprising the step of
2 repeating steps a) - f) for each subband.

1 23. The method defined in Claim 21 further comprising the step
2 of clipping the preferred reconstruction using minimum and maximum
3 possible values of the bits that are unknown.

1 24. An apparatus for creating a preferred reconstruction
2 comprising:
3 means for computing, for each SD coefficient, a preferred
4 reconstruction and clipping the preferred reconstruction to be consistent
5 with quantization;
6 means for performing an inverse vertical transform on SS and SD
7 coefficients only;
8 means for computing, for each DS and DD coefficient, a preferred
9 reconstruction and clipping the preferred reconstruction to be consistent
10 with quantization;

11 means for performing the inverse vertical transform on DS and
12 DD coefficients on two current lines of coefficients using DS coefficients
13 from two previous lines;

14 means for performing an inverse horizontal transform for two
15 vertically adjacent S and D coefficient pairs in said two current lines of
16 coefficients; and

17 wherein the means for performing the inverse vertical transform
18 on DS and DD coefficients and the means for performing an inverse
19 horizontal transform for two vertically adjacent S and D coefficient pairs
20 operate repeatedly for each pair of lines after the two current lines.

1 25. The apparatus defined in 24 further the operations are
2 repeated for each subband.

1 26. The apparatus defined in Claim 24 further comprising
2 means for clipping the preferred reconstruction using minimum and
3 maximum possible values of the bits that are unknown.

1 27. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor
4 to:

- 5 a) for each SD coefficient, compute a preferred reconstruction and
- 6 clipping the preferred reconstruction to be consistent with quantization,
- 7 b) perform an inverse vertical transform on SS and SD coefficients
- 8 only,
- 9 c) for each DS and DD coefficient, compute a preferred
- 10 reconstruction and clipping the preferred reconstruction to be consistent
- 11 with quantization,
- 12 d) perform the inverse vertical transform on DS and DD
- 13 coefficients on two current lines of coefficients using DS coefficients from
- 14 two previous lines,
- 15 e) perform an inverse horizontal transform for two vertically
- 16 adjacent S and D coefficient pairs in said two current lines of coefficients,
- 17 and
- 18 f) repeat d) and e) for each pair of lines after the two current lines.

- 1 28. A method for processing encoded data, said method
- 2 comprising the steps of:
- 3 receiving an indication of the amount of data used to encode
- 4 importance levels over n tiles in the encoded data;
- 5 determining a predetermined amount of the encoded data to
- 6 decode; and
- 7 decoding only the predetermined amount of the encoded data so
- 8 that decoded data is obtained with the same fidelity over each tile.

1 29. The method defined in Claim 28 wherein the decoding only
2 the portion of the encoded data comprises decoding the encoded data
3 starting with highest importance level and continuing in succession to
4 lower importance levels until a predetermined amount of the encoded
5 data has been decoded.

1 30. An apparatus for processing encoded data, said apparatus
2 comprising:
3 means for receiving an indication of the amount of data used to
4 encode importance levels over n tiles in the encoded data;
5 means for determining a predetermined amount of the encoded
6 data to decode; and
7 means for decoding only the predetermined amount of the
8 encoded data so that decoded data is obtained with the same fidelity over
9 each tile.

1 31. The apparatus defined in Claim 30 wherein the means for
2 decoding comprises means for decoding the encoded data starting with
3 highest importance level and continuing in succession to lower
4 importance levels until a predetermined amount of the encoded data has
5 been decoded.

1 32. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor
4 to:

5 receive an indication of the amount of data used to encode
6 importance levels over n tiles in the encoded data;

7 determine a predetermined amount of the encoded data to decode;
8 and

9 decode only the predetermined amount of the encoded data so that
10 decoded data is obtained with the same fidelity over each tile.

1 33. A method of processing data comprising:
2 receiving a plurality of quantized zero coefficients;
3 injecting noise into the image by selecting appropriate
4 reconstruction values for the quantized zero coefficients.

1 34. The method defined in Claim 33 wherein the noise injected
2 is a function of noise in an original image from which the plurality of
3 quantized zero coefficients were generated.

1 35. The method defined in Claim 34 further comprising the step
2 of receiving information regarding the noise in the original image in a

3 tag accompanying compressed coefficients from which the plurality of
4 quantized zero coefficients are derived.

1 36. The method defined in Claim 35 wherein the information
2 comprises a distribution of noise in the original image.

1 37. The method defined in Claim 35 wherein the information
2 comprises the amplitude of noise in the original image.

1 38. The method defined in Claim 35 wherein the information
2 comprises the variance of noise in the original image.

1 39. An apparatus for processing data comprising:
2 means for receiving a plurality of quantized zero coefficients;
3 means for injecting noise into the image by selecting appropriate
4 reconstruction values for the quantized zero coefficients.

1 40. The apparatus defined in Claim 39 wherein the noise
2 injected is a function of noise in an original image from which the
3 plurality of quantized zero coefficients were generated.

1 41. The apparatus defined in Claim 40 further comprising
2 means for receiving information regarding the noise in the original

3 image in a tag accompanying compressed coefficients from which the
4 plurality of quantized zero coefficients are derived.

1 42. The apparatus defined in Claim 41 wherein the information
2 comprises a distribution of noise in the original image.

1 43. The apparatus defined in Claim 41 wherein the information
2 comprises the amplitude of noise in the original image.

1 44. The apparatus defined in Claim 41 wherein the information
2 comprises the variance of noise in the original image.

1 45. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor
4 to:
5 receive a plurality of quantized zero coefficients;
6 inject noise into the image by selecting appropriate reconstruction
7 values for the quantized zero coefficients.

1 46. A method of processing tiles of encoded data comprising the
2 steps of:

3 storing a tile having a tile size in a portion of memory larger than
4 the tile size; and
5 performing decoding operation on coefficients in the tile stored in
6 the portion of memory using a pointer to a location in the tile and a
7 series of offsets from the location to locate a set of coefficients for access
8 during decoding of each individual coefficient.

1 47. The method defined in Claim 46 wherein the portion of
2 memory outside the tile stores a predetermined value.

1 48. The method defined in Claim 47 wherein the
2 predetermined number is 0.

1 49. The method defined in Claim 46 wherein the offsets are
2 fixed.

1 50. An apparatus processing tiles of encoded data comprising:
2 means for storing a tile having a tile size in a portion of memory
3 larger than the tile size; and
4 means for performing decoding operation on coefficients in the
5 tile stored in the portion of memory using a pointer to a location in the
6 tile and a series of offsets from the location to locate a set of coefficients
7 for access during decoding of each individual coefficient.

1 51. The apparatus defined in Claim 50 wherein the portion of
2 memory outside the tile stores a predetermined value.

1 52. The apparatus defined in Claim 51 wherein the
2 predetermined number is 0.

1 53. The apparatus defined in Claim 50 wherein the offsets are
2 fixed.

1 54. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor
4 to:
5 store a tile having a tile size in a portion of memory larger than
6 the tile size, and
7 perform decoding operation on coefficients in the tile stored in the
8 portion of memory using a pointer to a location in the tile and a series of
9 offsets from the location to locate a set of coefficients for access during
10 decoding of each individual coefficient.

1 55. A method of decoding data, said method comprising the
2 steps of:

3 identifying when a plurality of identical contexts are to be provided
4 to an entropy coder; and
5 performing a single coding operation for all of the plurality of
6 identical contexts if the plurality of identical contexts occur in succession.

1 56. The method defined in Claim 55 wherein the step of
2 identifying when a plurality of identical contexts are going to be provided
3 to an entropy coder comprises comparing a portion of an encoded input
4 data stream to a prediction of what the encoded input data stream should
5 be if the plurality of identical contexts occur in succession.

1 57. The method defined in Claim 55 wherein the step of
2 identifying when a plurality of identical contexts are going to be provided
3 to an entropy coder comprises comparing a portion of an encoded input
4 data stream to a pair of predictions of what the encoded input data stream
5 should be if the plurality of identical contexts occur in succession,
6 wherein the coding operation is performed when the encoded input data
7 stream is equal to either prediction in the pair of predictions or falls
8 between the pair of predictions.

1 58. An apparatus decoding data comprising:
2 means for identifying when a plurality of identical contexts are to
3 be provided to an entropy coder; and

4 means for performing a single coding operation for all of the
5 plurality of identical contexts if the plurality of identical contexts occur in
6 succession.

1 59. The apparatus defined in Claim 58 wherein means for
2 identifying comprises means for comparing a portion of an encoded
3 input data stream to a prediction of what the encoded input data stream
4 should be if the plurality of identical contexts occur in succession.

1 60. The apparatus defined in Claim 58 wherein the means for
2 identifying comprises means for comparing a portion of an encoded
3 input data stream to a pair of predictions of what the encoded input data
4 stream should be if the plurality of identical contexts occur in succession,
5 wherein the coding operation is performed when the encoded input data
6 stream is equal to either prediction in the pair of predictions or falls
7 between the pair of predictions.

1 61. A computer software product including a medium readable
2 by a processor, the medium having stored thereon a sequence of
3 instructions which, when executed by the processor, causes the processor
4 to:

5 identify when a plurality of identical contexts are to be provided to
6 an entropy coder; and

7 perform a single coding operation for all of the plurality of
8 identical contexts if the plurality of identical contexts occur in succession.

1 62. A method of reconstructing comprising the steps of:
2 determining a difference between a first coefficient and a second
3 coefficient of predetermined number of coefficients where the first
4 coefficient has a minimum value among the coefficients and the second
5 coefficient has a maximum value among the coefficients;
6 reconstructing to other than a step edge where the difference
7 between the predetermined number of coefficients is less than a
8 predetermined threshold value;
9 reconstructing to a step edge where the difference between the
10 predetermined number of coefficients is greater than a predetermined
11 threshold value, wherein the step of reconstructing to a step edge
12 comprises the steps of
13 computing first and second partial reconstruction values
14 based on a predetermined number of coefficient values to the right and to
15 the left of a location of a potential step edge,
16 computing a reconstruction value using one of the first and
17 second partial reconstruction values based on whether one of the first
18 and second partial reconstruction values is zero and whether signs of the
19 first and second partial reconstruction values are the same.

1 63. The method defined in Claim 62 wherein the resulting
2 reconstruction is to linear where the difference between the
3 predetermined number of coefficients is less than the predetermined
4 threshold value.

1 64. The method defined in Claim 62 wherein the
2 predetermined number of coefficients comprise S coefficients only.

1 65. The method defined in Claim 62 wherein the
2 predetermined number of coefficients is 5.

1 66. The method defined in Claim 62 wherein a partial
2 reconstruction value of 0 is used in computing the reconstruction value
3 if either of the first or second partial reconstruction values is 0.

1 67. The method defined in Claim 62 wherein a partial
2 reconstruction value equal to a partial reconstruction value having a
3 minimum value as between the first or second partial reconstruction
4 values if signs of the first or second partial reconstruction values are the
5 same.

1 68. The method defined in Claim 62 wherein computing at least
2 one of the first and second partial reconstruction values comprises:

3 determining differences between outer and inner pairs of
4 coefficient values;
5 testing whether magnitude of the difference between the outer pair
6 is greater to magnitude of the difference between the inner pair;
7 setting the differences equal to each other if the magnitude of the
8 difference between the outer pair is greater to the magnitude of the
9 difference between the inner pair;
10 computing a ratio of the difference between the outer pair to the
11 difference between the inner pair; and
12 setting said at least one of the he first and second partial
13 reconstruction values to a product of the difference between the inner
14 pair and a result derived using the ratio.

1 69. The method defined in Claim 68 wherein the outer and
2 inner pairs of coefficient values comprise S coefficients.

1 70. A method for performing a reconstruction comprising the
2 steps of:
3 generating a reconstruction value; and
4 clipping the reconstruction value if the reconstruction value
5 exceeds the bounds of neighboring coefficients, where the reconstruction
6 value is clipped to a coefficient value within the bounds of the

7 neighboring coefficients. of a neighboring coefficient with a value closest
8 to the reconstruction value.

1 71. The method defined in Claim 70 using a center sample as
2 the reconstruction value if the subsequent reconstruction value does not
3 exceed the bounds of neighboring coefficients.

1 72. The method defined in Claim 70 using a sample value of
2 one of a plurality of immediate neighbors of a center sample as the
3 reconstruction value if the subsequent reconstruction value does not
4 exceed the bounds of neighboring coefficients.

1 73. The method defined in Claim 72 wherein the sample value
2 of the one of the plurality of the immediate neighbors has a value closer
3 to the center sample than the other of the he plurality of the immediate
4 neighbors.

1 74. The method defined in Claim 70 wherein the neighboring
2 coefficients comprise neighboring S coefficients.

1 75. The method defined in Claim 70 where the reconstruction
2 value is clipped to a coefficient value of a neighboring coefficient with a
3 value closest to the reconstruction value.

1 76. A method of modeling binary data comprising the steps of:
2 determining whether a first predetermined number of bits in a
3 frequency band are the same;
4 sending a first bit having a first state and a second bit to a coder if
5 the predetermined number of bits in the frequency band are the same,
6 where the second bit indicates whether the first predetermined number
7 of bits are all 1 or all 0;
8 sending the first bit having a second state different from the first
9 state to the coder if the first predetermined number of bits in the
10 frequency band are not the same;
11 if the first predetermined number of bits in the frequency band are
12 not the same, then determining whether a second predetermined
13 number of bits are the same;
14 sending a third bit indicating whether the second predetermined
15 number of bits are the same; and
16 sending a context for a target bit based on neighboring coefficients
17 if the second predetermined number of bits are not the same.

1 77. The method defined in Claim 76 wherein the
2 predetermined number of bits comprises all target bits.

1 78. The method defined in Claim 76 wherein the step of
2 determining whether the second predetermined number of bits are the

3 same comprises determining whether the second predetermined number
4 of bit are zero head bits.

1 79. A method for processing data comprising the steps of:
2 determining whether to attempt to code a predetermined number
3 of coefficients as a group;
4 coding the predetermined number of coefficients individually
5 using a first context model if not attempting to code the predetermined
6 number of coefficients as a group;
7 first coding the predetermined number of coefficients when the
8 data is in a predetermined state and attempting to code the
9 predetermined number of coefficients as a group is successful; and
10 second coding each coefficient in the predetermined number of
11 coefficients independently when the data is not in the predetermined
12 state and attempting to code the predetermined number of coefficients as
13 a group fails, wherein second coding uses a second context model
14 different than the first context model.

1 80. The method defined in Claim 79 wherein the step of first
2 coding comprises coding a bit having a first state with a lookahead
3 context.

1 81. The method defined in Claim 80 further comprising the step
2 of skipping the predetermined number of coefficients.

1 82. The method defined in Claim 79 wherein the data is in a
2 predetermined state when certain bits in the predetermined number of
3 coefficients, parents of those coefficients or northern neighbor coefficients
4 of the predetermined number of coefficients comprise all zero head bits.

1 83. The method defined in Claim 79 wherein the coding of each
2 coefficient independently comprises:

3 decoding head bits of each coefficient until a first 1 bit occurs;
4 coding a sign bit of said each coefficient when the first 1 bit occurs;
5 and
6 coding tail bits of said each coefficient thereafter.

1 84. The method defined in Claim 79 further comprising coding
2 bit planes of individual frequency bands in a child-based order.

1 85. The method defined in Claim 79 wherein bits in each
2 importance level are coded in frequency band order.

- 1 86. The method defined in Claim 79 wherein the second context
- 2 model is based on neighboring coefficients in the same frequency band
- 3 and a parent coefficient.